

Dynamic Form: A Mobile-based Solution for COVID-19 Hospital Assessment Form

Majed I. Bin Osfoor*, Hosam A. Alfaleh*, Abdullah M. Albarrak**

*King Abdulziz City for Science and Technology, Saudi Arabia
{mbosffor, halfaleh}@kacst.edu.sa

**Imam Mohammad Ibn Saud Islamic University, Saudi Arabia
amsbarrak@imamu.edu.sa

Abstract—This paper presents an effective mobile-based solution for a real-world problem. A major task of the National Saudi Center for Diseases Prevention and Control (Weqaya) is to “monitor, measure and evaluate population health and related risk factors” in order to continuously monitor the number of cases which play an important role in preventing communicable diseases such as COVID-19. The current solution used by Weqaya to accomplish the aforementioned task involves sending static forms to all hospitals (in PDF format) with a set of static predefined questions concerning admitted cases. Accordingly, health care workers (HCWs) fill in these forms and return them back to Weqaya. A major limitation with this solution is the approach in which these static forms are submitted, which is usually via Email. Additionally, these static forms contain too many questions that might not be related to all cases, i.e., some questions are related to cases who have already been admitted and are under certain treatments. Showing these questions for newly admitted cases that are yet to be given a treatment is meaningless.

To overcome the above limitations, and by collaborating with an official team from the Saudi Ministry of Health, we propose Dynamic Form. The aim of Dynamic Form is to provide an effective solution in lieu of the current static forms. Specifically, Dynamic Form is accessed directly from any mobile device, hence, eliminating the tedious handling of PDF files and also facilitating the practical and convenient process for submitting and receiving questions regarding admitted cases systematically.

Index Terms—Health informatics, syndromic surveillance, mobile applications, data management

I. INTRODUCTION

The Saudi Center for Disease Prevention and Control¹ (Weqaya) was officially established in 29th April 2013 and was appointed to the task of preventing communicable diseases outbreaks. Via continuous monitoring and evaluation of population health, Weqaya is able to plan and strategize for intervention in epidemic situations.

By the end of year 2019 and the beginnings of 2020, a novel infectious coronavirus (termed later as COVID-19) started to spread from its origins in Wuhan, China to the rest of the world [1]. On the 2nd of March 2020, the first case was reported in Saudi Arabia [2]. Since Weqaya is the designated entity that is responsible monitoring the population health during epidemics, they started implementing and deploying syndromic surveillance systems [3] rigorously.

¹<https://covid19.cdc.gov.sa/about-us/>

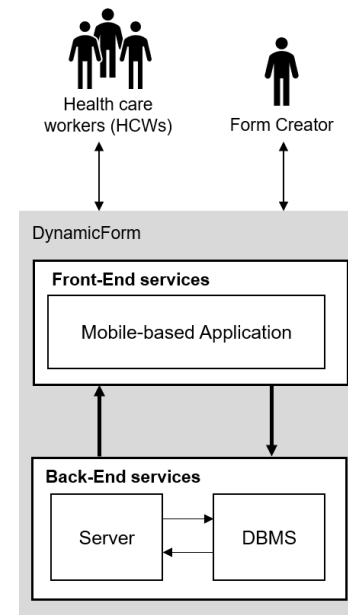
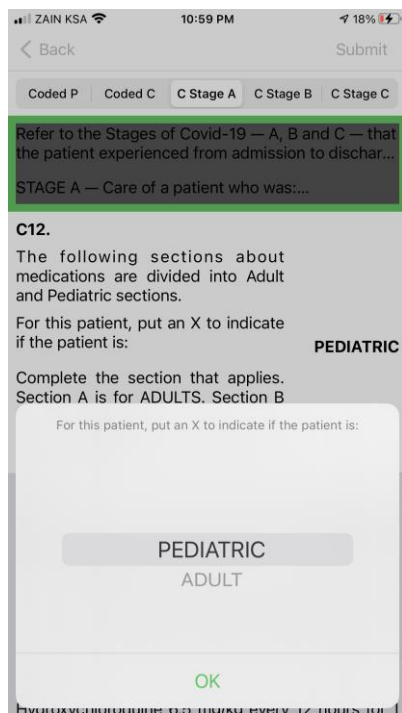


Fig. 1: An architectural block diagram of Dynamic Form which illustrates how it is decomposed into two main components.

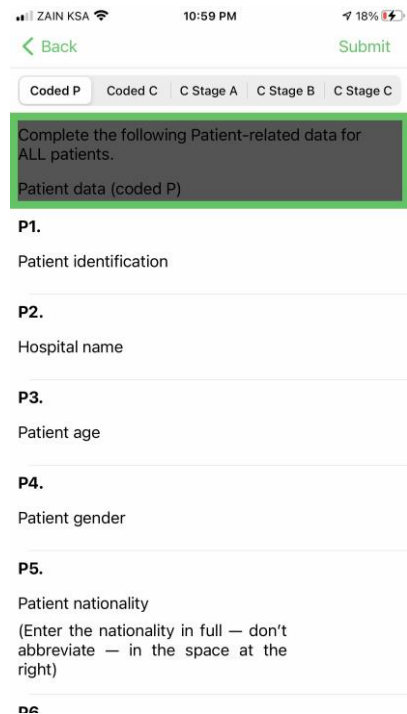
One of these systems involves sending static forms (in PDF format) to designated hospitals to collect specific clinical features and pre-diagnostic data (on inpatients and outpatients) to monitor the population health status. Health care workers (HCWs) are expected to fill in these forms manually and return them back to Weqaya via a pre-agreed email address.

While this system seems suitable, it suffers from multiple limitations. The proposed solution, Dynamic Form, is an attempt in the direction of improvement upon traditional methods of public health surveillance. Dynamic Form aims to minimize manual efforts appointed towards filling in these forms, and eliminating flaws in handling these forms. Further, Dynamic Form aims to optimize the way in displaying and answering the questions in ways that are not possible with the static forms.

Paper Layout: Section II demonstrates the motivation behind developing Dynamic Form by unmasking the limitations of the current solution. Then, Section III illustrates the technical details of Dynamic Form and how it addresses these limitations.



(a) A screenshot of Dynamic Form mobile app. The answer for question C12 determines the next questions which the app should show. Dynamic Form can seamlessly do this by using already entered data in other questions.



(b) A screenshot of Dynamic Form mobile app. The questions in the patient information section enables Dynamic Form to show relevant questions in other sections, and also some of these can be automatically filled in using the Back-End services of Dynamic Form (e.g., nationality, age)

Fig. 2: Two screenshots of Dynamic Form mobile application.

Section IV concludes this paper by discussing the system's usage and the potentials of deploying Dynamic Form in other areas.

II. MOTIVATION

The National Saudi Center for Diseases Prevention and Control (Weqaya) oversees the activities of communicable diseases such as COVID-19 and aims to achieve a unified and consistent timely actions. The process to achieve that aim starts by sending static forms (in PDF format) to all designated hospitals². These forms are referred to as "COVID-19 Clinical Audit Data Collection Form". The form consist of 14 pages and is divided into two sections: patient data section (P), and care data sections (C), where the former contains 11 questions and the latter contains 18 questions with possible multiple sub-questions. Health care workers (HCWs) in these hospitals are expected to fill in these forms manually and submit them back to Weqaya via Email that has already been agreed upon. Accordingly, Weqaya use these data as a mechanism to realize the principles of infection prevention and control protocols through early recognition and source control of communicable diseases.

Clearly, this process exhibits multiple limitations, namely:

- 1) A tedious and tiresome manual labor on the HCWs side. Filling in a 14 pages form with 29 compound questions that require a lot of time and effort is not a straightforward task, especially for those how are under certain work-related pressure such as HCWs. Additionally, manual handling of receiving and submitting these filled forms could possibly entail blunder faults, e.g., forgetting to submit a filled form, typing the email address incorrectly, etc.
- 2) Static PDF form with too many questions that might not be related to all admitted cases. The way in which these 29 compound questions are presented is not optimized. That is, there are specific questions which are to be answered only if a patient has already been admitted before. Moreover, there are other specific questions which are relevant to adults only. These questions should not be presented if the admitted case is a child. Furthermore, some questions related to previously admitted cases can be either answered after looking up previous filled forms manually, or are considered duplicate questions (especially questions in P section).

The proposed solution, Dynamic Form, address all these aforementioned limitations. Specifically, Dynamic Form provides a trouble-free and convenient process for HCWs to fill in electronic forms in the most suitable structure and shape, thus,

²There are 20 designated hospitals for COVID-19 as of February 2020 in Saudi Arabia.

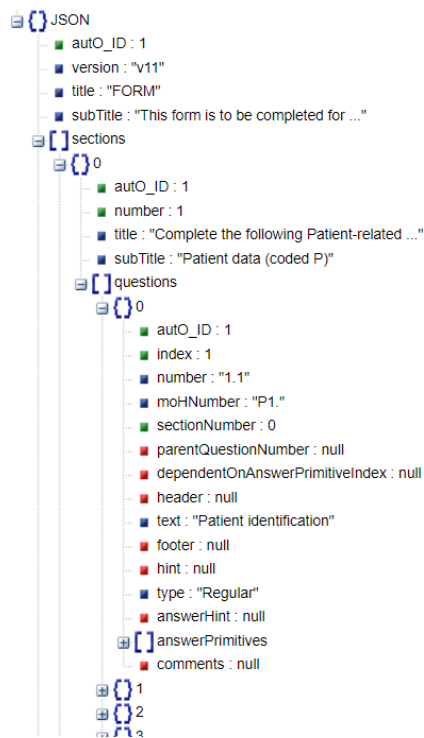


Fig. 3: A partial visualization of the JSON file used to encode the questions in the electronic form. It contains an array of objects for encoding sections, and each section object contains an array of objects for encoding questions as well.

ensuring a seamless process of filling in forms and submitting them over to Weqaya.

Besides, with the advanced back-end services of Dynamic-Form, further analytic steps can be performed on raw collected data that are most certainly more accurate than manual-collected data [4]. In the next section, we discuss the proposed solution in more details.

III. PROPOSED SOLUTION: DYNAMIC FORM

As mentioned in previous sections, Dynamic Form is proposed as an alternative and much more effective solution for the process of collecting answers for the “COVID-19 Clinical Audit Data Collection” form. The solution consists of two main modules (Figure 1): a front-end module which encapsulates all user interaction related services, and a back-end module that is responsible for managing all infrastructure services.

A. Front-End Module

The front-end module is a mobile application developed for iOS devices, i.e., iPhones and iPads. Obviously, using these devices for data entry is much more superior than handwriting when it comes to filling up forms, as research suggests [5], [6]. Hence, the mobile application of Dynamic Form was designed with a focus on how to minimize user effort. Simple design tricks such as answering compound questions in a step-by-step process proved to be much more easier for users than

answering the same questions all at once. Also, using the back-end services to systematically answer some questions is possible with Dynamic Form and increases the efficiency in filling these forms.

For instance, the compound question C12 in Figure 2a is for adults and children. The sub-questions within that compound question depend on the age of the patient, i.e., whether the patient is an adult or a child. Once the user type in the patient information in the P section (as shown in Figure 2b), Dynamic Form automatically shows the relevant questions of C12, i.e., either the ones for adults or children.

Further, other compound questions start with a yes/no question. The answer for this question determines what questions Dynamic Form should present next. Hence, minimizing the number of questions shown to users.

Surely, the above usage scenarios are focused on the HCWs as users of the mobile application. Dynamic Form also supports the form creator (i.e., Weqaya) by allowing remote access to the form in order to edit, add, delete or update any questions remotely. Consequently, changes are reflected immediately in the mobile application for which HCWs can answer these up-to-date questions.

Since this mobile application is intended to be used within hospitals, it was required that connectivity to the Back-End services be transparent to end-users, i.e., users of the application should be able to use it even though connection to these services is not active. Consequentially, any submitted forms will be kept locally in the device until connection is restored. Once the connection is restored, the application will upload this locally-stored data to the Back-End services.

B. Back-End Module

This module is mainly dedicated for managing the questions which are displayed by the front-end module. Essentially, this module is implemented as a server which the mobile application connect with to retrieve the designated version of the questions and to upload questions answers that are submitted into a database. Also, the form creator (i.e., Weqaya) connects with the server to submit newer versions of questions (e.g., update, edit, or add new questions) and to specify which questions versions should be displayed by the front-end.

Initially, form creator encodes the questions in a JSON file, then submit this file to the server. Then, the server parses the JSON file and upload the questions to a database. The server implicitly associates versions to each uploaded question, and gives the ability to form creators to choose which versions are displayed to HCWs by the front-end. Updates are instantaneously reflected on the mobile application.

As shown in Figure 3, the JSON file is used to encode the electronic form, which is in turn is read by the server to populate the database. The mobile application then reads the questions from the database and display them to the HCWs. Once HCWs finish typing in the questions' answers, they are inserted into the database by the server.

Dynamic Form uses Microsoft SQL Server Database to store all data related to questions and their answers. Figure 4

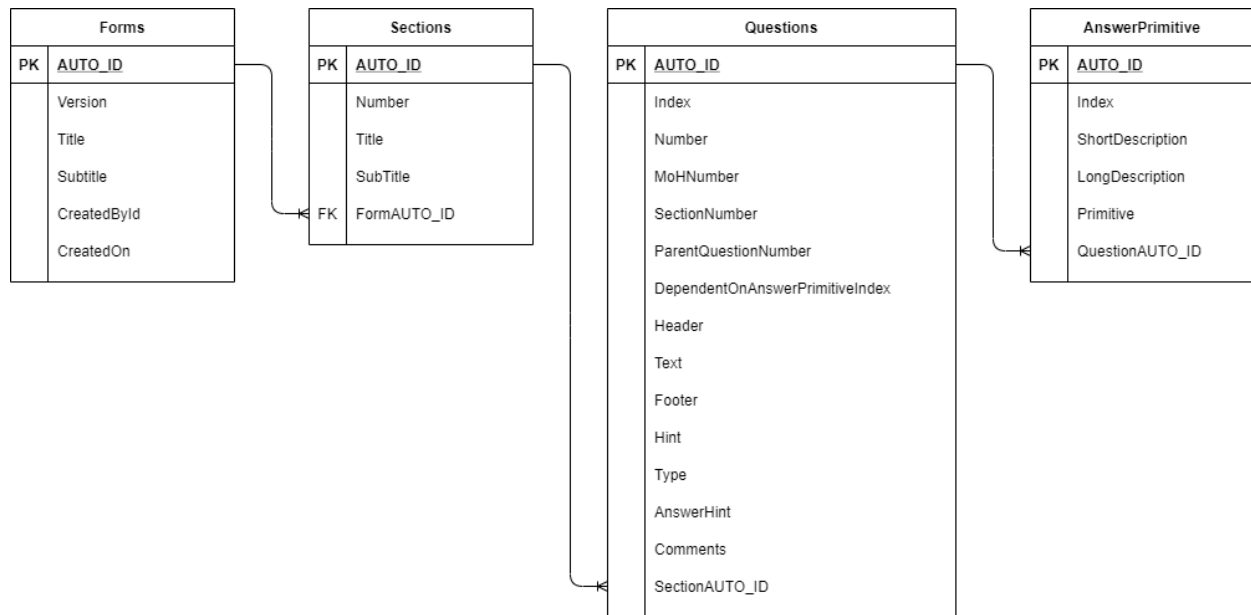


Fig. 4: Dynamic Form uses Microsoft SQLServer database to store questions and their answers. It consists of 10 relations. This is a partial view of the database schema which demonstrates how questions and answers are stored.

illustrates a partial view of the database schema: each form can have one or more sections, and each section can have one or more questions. Since a question can have more than one version (e.g., when a question is updated it will be assigned a new index), each question can have one or more answers.

IV. DISCUSSION AND CONCLUSION

The proposed solution described above is supposed to replace the current manual process used by Weqaya and its stakeholders for collecting clinical data on admitted cases. As also described above, Dynamic Form overcomes the limitations of the used manual process and enables further analysis steps of the collected data by storing all answers in a adequately designed database.

The typical usage of Dynamic Form starts by converting a static form into a predefined JSON format. Sections and questions of the form are encoded in that format by form creators (i.e., Weqaya) and is uploaded to the server. At the same time, HCWs download the mobile application on their iOS devices and register as regular users. Once Weqaya approve of the questions and choose the questions versions to be displayed, HCWs will be able to see these questions in the front-end (i.e., the mobile application). Next, HCWs will type in answers for each admitted patient and submit these answers back to the server through the application. The server then automatically inserts these answers into the database.

Certainly, Dynamic Form can be applied to other areas in which manual forms are used. The current design of Dynamic Form is highly universal and inclusive, i.e., if another entity collects data using manual forms, then Dynamic Form can be applied directly. For instance, the Saudi Food and Drug Authority (SFDA) follows similar approaches to Weqaya in collecting data from its stakeholders. Thus, with minimal

modulations, this solution can be immediately deployed in place of the manual solution.

ACKNOWLEDGMENT

We would like to thank the Ministry of Health team for their valuable feedback and comments on early prototypes of Dynamic Form.

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